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ABSTRACT

How learning is understood in everyday schooling and conceptualized in research varies a great deal, as does the way in which writing is used for enhancing learning. This paper reviews recent research conducted mainly in Europe, North America, and Australia to outline what kind of challenges research is facing at the moment. The paper begins with examining how the concept of learning is defined in everyday use and in research. It considers the analysis of learning conceptions important because the way that learning is understood greatly determines how writing is used as a tool for learning. Second, it analyzes the theoretical basis for using writing as a learning tool--theories are divided into three categories: (1) theories from writing research; (2) theories from cognitive research on learning; and (3) theories representing the sociocultural approach to research on learning and language development. Third, the paper reviews recent empirical research based on these theoretical backgrounds. The studies reviewed in the paper illustrate the wide range of the ways writing is used for learning in schools and colleges. The paper's general conclusion is that the conception of learning underlying instruction is a decisive factor defining the nature of writing for learning. (Contains 127 references and a table of examples of how different views of learning lead to different pedagogical aims.) (NKA)

Writing As a Learning Tool.

by Paivi Tynjala

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WRITING AS A LEARNING TOOL

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INTRODUCTION

In the 1970s James Britton's studies in Britain indicated how school writing was narrowly focussed on transferring information instead of encouraging thinking and understanding. A few years later, inspired by Britton's ideas, Janet Emig (1977) in the United States published an essay "Writing as a Mode of Learning" (Emig, 1977), which became an inspiration for developing writing programmes known as Writing-Across-the-Curriculum (Sheridan, 1995). An essential aspect of these programmes was the idea that writing is a mode of learning as well as communication. The WAC programmes involved training and workshops for teachers across the disciplines about how to use writing for content-area learning and how to deal with students' writing problems. (Young & Fulwiler, 1986.) Since the mid-70s, the number of these variously named programmes (for example, writing in the disciplines, writing in the content areas, language and learning, writing-across-the-curriculum) has increased dramatically on all levels of the educational system from elementary grades to university (Herrington & Moran, 1992).

These developments were accompanied with growing amount of research on writing processes in general and on writing-to-learn in particular. In the nineteen eighties, studies of the effects of writing on learning produced contradictory and inconclusive results (see, for example, Geisler, 1994; Langer, 1986; Langer & Applebee, 1987; Newell & Winograd, 1989, Penrose, 1992; Schumacher & Nash, 1991). In some studies writing seemed to enhance learning but in other studies no difference was found as compared to other learning methods, or in some cases writing even proved less effective than, for example, "studying for a test" (Penrose, 1992).

As the field of writing-to-learn studies was incoherent and findings inconclusive Schumacher and Nash (1991) suggested that a change in focus in how we select tasks in writing-to-learn studies and in how learning is assessed is needed. They called for more theory-driven approach and especially emphasised that while selecting writing tasks for investigations it is important to draw on theoretical mechanisms thought to underlie learning. Furthermore, they defined learning as a conceptual change or knowledge change instead of reproduction of knowledge. During the 90's research on writing-to-learn has much applied ideas that Schumacher and Nash suggested. Many European, Australian and North American researchers have conducted studies based on cognitive theories and views of learning as knowledge construction (e.g. Boscolo & Mason, 2001; Keys, 1994; Lonka & Ahola, 1995; Mason, 1998; Mason & Boscolo, 2000; Prain & Hand, 1996; Spivey, 1990; Tynjälä, 1998). These studies as well as meta-analyses and reviews have confirmed that writing may produce positive effects on learning, but they have also revealed that the relationship

between writing and learning is not simple; writing does not automatically lead to better learning outcomes than do other learning methods (see Ackerman, 1993; Geisler, 1994; Klein, 1999; Penrose, 1992; Schumacher & Nash, 1991). How learning is understood in everyday schooling and conceptualised in research varies a great deal, as does the way in which writing is used for enhancing learning.

The purpose of this paper is to review recent research conducted mainly in Europe, North America and Australia and to outline what kind of challenges research is facing at the moment. I begin with examining how the concept of learning is defined in everyday use and in research. I consider the analysis of learning conceptions important because the way how learning is understood much determines how writing is used as a tool for learning. Second, I shall analyze the theoretical basis for using writing as a learning tool. In this section I divide the theories into three categories: 1) theories from writing research, 2) theories from cognitive research on learning, and 3) theories representing the sociocultural approach to research on learning and language development. Third, I shall review recent empirical research based on these theoretical backgrounds. My general conclusion is that the conception of learning underlying instruction is a decisive factor defining the nature of writing for learning.

WHAT IS LEARNING?

At first glance the question "what is learning" may sound trivial. "Of course we know what learning is", one may think, "we all have sat in school for years". However, the question of learning is not so simple. Both everyday learning conceptions of ordinary people and scientific conceptualisations of researchers vary a lot and have different implications for the idea of using writing in service of learning. Therefore, I begin my analysis by examining what kind of conceptions of learning have been identified among ordinary people and how the phenomenon of learning is seen in research and theory.

Marton, Dall'Alba and Beaty (1993) interviewed open university students on their conceptions of learning and distinguished between six different conceptions: 1) learning as increasing one's knowledge, 2) learning as memorising and reproducing, 3) as applying, 4) as understanding, 5) as seeing something in a different way, and 6) as changing as a person. Throughout the first three of these conceptions learning is seen as acquisition of something "ready-made" that exists "out there" waiting to be picked up and stored into one's memory. Thus, to learn is to become able to reproduce knowledge that someone else has created. In contrast, the three latter conceptions see learning more as transformation than reproduction. The watershed is *meaning*. While it is absent in the first three conceptions, it has a central role in the last three. To understand is to gain meaning, seeing something in a different way is to transform or change meanings, and changing as a person is to develop entirely new meaning structures for whole life.

The conceptions of learning described above represent students' thinking about learning but they may reflect teachers' views as well. The way in which students understand learning affects the way how they approach to their learning tasks and studying in general (Vermunt, 1998), and the way how teachers understand and conceptualise learning affects the way how they teach and support students' learning (Trigwell & Prosser, 1996; see also Dysthe, 1996). Until recently, most educational practices have been grounded on an objectivist epistemology and a common-sense view of teaching and learning as knowledge transmission. An objectivist epistemology assumes that knowledge exists independently of the knower and that teaching is a matter of transmitting this knowledge from the teacher or study materials to the student. Hence, learning is seen as the reception and storage of knowledge. In this view, assessment of learning is based on quantitative measures. Learners have learned the better the more knowledge they can reproduce in tests or examinations. During the last decade the knowledge transmission paradigm has been questioned by

the constructivist epistemology, which emphasizes that learning is about active construction of knowledge, not about passive reception of information. The acquisition of knowledge is metaphorically described as a building process in which knowledge is actively constructed by individuals, groups or social communities. In this view, assessment of learning is seen qualitatively and attention is paid on what kind of knowledge structures students construct and how.

Different branches of constructivist thought have somewhat different pedagogical implications (see, for example, Steffe & Gale, 1995). Cognitive constructivists are interested in individuals' knowledge construction processes and the development of mental models, while social constructivists, the sociocultural approach and social constructionists are more interested in social, dialogical and collaborative processes and put great emphasis on language and discourse. The interactionist view attempts to include both individual and social aspects. Because cognitive constructivism emphasises changes in individual students' knowledge structures and mental models, its pedagogical applications aim to develop tools for promoting conceptual change. Social constructivists, the sociocultural approach and situationalists have emphasised social interaction, collaboration and authentic learning tasks. Social constructionists stress discourse and the negotiation of meaning and are less interested in what is taking place in individual students' heads.

The division between constructivism, social constructivism and constructionism described above is one way to outline different schools of thought in learning research. Another division is provided by Sfard (1998) who has summarized the various branches of research on learning as representing two major pathways labeled as the acquisition metaphor and the participation metaphor. The former analyses learning as knowledge acquisition while the latter emphasizes that learning is a process of becoming a member of a certain community and becoming able to communicate and participate within this community. The acquisition metaphor provides us with an understanding of individuals' cognitive knowledge construction while the participation metaphor involves a cultural view into the research on learning. These different paradigms may be seen as complementary views which both are needed in order to understand the nature of learning.

In short, the concept of learning may be understood in a variety of ways: as acquisition and reproduction of knowledge, as transformation of knowledge, as construction of knowledge and conceptual change, as becoming a different person, or as becoming an active participant in a community of practice. Then, how learning is seen has implications on how teachers arrange learning situations for their students. In table 1 there are some examples. The table illustrates how different views of learning lead to different pedagogical aims and different learning tasks assigned to learners. This way the role of writing and the forms of writing as learning tool vary depending on the conceptions of learning.

Although different theories of learning may have different pedagogical implications there are some common features in current pedagogical thinking. They can be summarised as follows:

1) *Learner-centredness*. All current learning theories emphasise the active role of a learner and that the student's activity is the focal point of any learning situation. The teacher's role remains important but it changes from that of a transmitter of information to a guide of students' learning process and to an expert model for the skills to be learned.
2) *Process orientation*. The centrality of the learning processes over the final product is visible in current learning theories in two ways. First, cognitive constructivist pedagogics pay much attention to learners' learning processes and their meta-cognitive and self-regulative skills (Boekaerts, 1997; Vermunt, 1995; Vermunt, 1998; von Wright, 1992). It is considered important that students become aware of their learning strategies and preferences and learn to reflect on and regulate their learning processes. Students are encouraged to focus on understanding and on meaningful learning instead of simple rote learning and reproduction of information. This is supported by shifting the focus from learning detailed facts to a problem

orientation. Second, the socio-cultural approaches emphasize learning processes by describing learning as active participation in cultural practices (Brown et al., 1989; Lave & Wenger, 1991).

Table 1. Examples of different conceptions of learning and their implications to the aims of learning situations and the tasks assigned to students. (In first two examples the students are assumed to be about sixth graders, in the last two they are university students in teacher education)

Conception of learning	The aim of the learning situation	Learning tasks for students
1. Learning as reproduction of knowledge	Students can describe how photosynthesis takes place	1) Read a chapter about photosynthesis 2) Underlie the most important points, 3) Write down these points 4) Read your notes and memorise the important points, 5) Write the description of photosynthesis from your memory (in a test)
2. Learning as conceptual change	Students become aware of their conception of photosynthesis (how plants get energy) and change their thinking towards the scientific explanation	1) Write down what you think how plants get energy and discuss your conceptions with your peers, 2) Read the chapter about photosynthesis, 3) Discuss with your peers and the teachers about how plants get energy 4) Write down your conceptions on plants' energy and how your conceptions have changed
3. Learning as a change as a person	To develop student teachers' identity as a teacher	Keep a journal on your experiences during your practice period at school. Reflect on your experiences of teaching children in the light of theoretical knowledge on learning. At the beginning of the period, set your personal learning goals. At the end, examine how you have achieved your goals, what are your strengths and what you still need to learn to become a good teacher.
4. Learning as becoming an active participant in a community of practice	To develop student teachers' identity as a teacher and to support their participation in a community of practice (which in this case is a school)	The same as above + Observe expert teachers' ways of handling problems in the classroom and practice these ways in your own classes. Reflect your experiences in your journal and discuss them with your supervisor/tutor and peers.

3. *Multidimensionality and diversity in learning.* The importance of diversity and multidimensionality is expressed in different ways in different schools of thought. Social constructionism (Berger & Luckmann, 1979; Gergen 1995) presents reality as a social construction which is built in the interaction between individuals and the community. Even "objective facts" are produced through social meaning making and negotiation. That is, they are socially constructed, not objectively discovered. It is therefore important in teaching to emphasise the relativity of knowledge and familiarise students with the various ways of producing knowledge. Cognitive constructivists, in turn, stress that although common language and culture enable us to understand things in basically the same way, people, because of their individual experiences, may attribute things different meanings. It is therefore important that different interpretations by learners are taken into account and discussed. Diversity has been argued for also by the situated learning camp, although on different grounds. Theorists of situated learning emphasise that we learn not only a subject but also cultural practices – and that we learn subjects *through* cultural practices (Brown, Collins, & Duguid, 1989; Lave & Wenger, 1991; Mandl et al., 1996). It is therefore important that learning situations are as authentic as

possible and that the cultures of learning and studying simulate real-life situations and the cultures of working life.

4. *Social interaction.* Both cognitive constructivist (e.g. Piaget, 1963) and socio-cultural thought (e.g. Vygotsky, 1986) emphasise the significance of social interaction in learning although the mechanisms of the social influence are seen differently (see, Rogoff, 1999). In Piaget's view, social interaction brings about cognitive conflict within an individual, whereas according to Vygotsky learning takes place *between* partners. In any case, social interaction has two-way effects: first, it requires an individual to externalise their thinking and, second, it makes it possible for an individual to internalise ideas presented on the social plane. Therefore, negotiating and sharing meanings through discussion and different forms of collaboration are considered essential elements of learning (Dillenbourg, 1999; Gergen, 1995).
5. *Development of curricula and assessment.* Finally, all current theoretical views of learning have criticised traditional ways of schooling and instruction and argued for pedagogical reforms including curricular development and inventing new assessment methods. Because of the constantly developing and changing nature of knowledge, the contents of curricula cannot be strictly defined beforehand. Instead, curricula should present general aims and emphasise the development of students' metacognitive and lifelong learning skills. Furher, a movement from discipline-based towards problem-based curricula is going on. The need to develop assessment procedures that are embedded in the learning processes, focus on authentic tasks, pay attention to learners' individual orientations and foster their metacognitive skills has been stressed (Biggs, 1996; Boud, 1995; Dochy & Moerkerke, 1997; Jonassen, 1991). Traditional examinations often lead students to adopt a surface approach to learning and studying and to attempt to memorise the material instead of trying to understand it (Biggs, 1996; Entwistle & Entwistle, 1992; Entwistle et al., 1993). In contrast, assessment methods that are based on the learning process itself and encourage students to engage in metacognitive and reflective activities are in harmony with the new theories of learning. Assessment methods of this kind rely on learning assignments rather than on separate test situations and include also self- and peer assessment and the use of portfolios.

THEORETICAL BASIS FOR WRITING-TO-LEARN

Theoretical foundations for using writing in service of learning may be searched from at least three directions, first, from the cognitive research on the writing process, second, from the cognitive and constructivist research on learning, and, third, from socio-cultural schools of language and learning. In the following sections I shall examine the theoretical basis that each of these lines of research provide for writing-to-learn. Thereafter I review empirical studies on writing-to-learn conducted recent years in Europe, North America and Australia.

Theories from writing research

In his recent review article Klein (1999) has distinguished between four different hypotheses about why writing may enhance learning. The first of these hypotheses based on theories of writing is related to *spontaneous idea generation*: writers spontaneously generate knowledge "at the point of utterance" as Britton (1982) has put it. Writers do not necessarily know exactly what to write when starting to write, inventing the content only as they produce the language (see Galbraith, 1992, 1999). Thus, this hypothesis assumes that the power of writing for learning lies in its creative and constructive nature. The second hypothesis is what Klein calls a "*forward search hypothesis*". Forward search is the process where writers review their first drafts in order to transform their ideas

through operations such as drawing inferences and detecting contradictions. According to this hypothesis, writers first externalise their ideas, then reread them to develop them further. The third hypothesis about the cognitive mechanisms of writing-to-learn is a *genre hypothesis* which assumes that genre structures are used to organise text and knowledge and that different genres require different cognitive strategies. The studies based on this hypothesis have compared different genres used in writing-to-learn, such as analytic writing, personal writing, argumentation, note-taking, and answering questions, and found differences in learning outcomes. For example, tasks requiring only minimal elaboration seem to produce only verbatim recall while tasks requiring complex elaboration, such as analytic essay writing, promote understanding (e.g. Langer, 1986; Wiley & Voss, 1996). The fourth hypothesis, which Klein calls a "*backward search hypothesis*", assumes that writers construct knowledge by setting rhetorical goals, generating content to address these goals, and then revising their rhetorical goals to accommodate this content. Thus, in models of writing based on this hypothesis rhetorical and content-related problems interact. Klein mentions the problem-solving models of Flower and Hayes (1980) and Bereiter and Scardamalia (1987) as examples of such explanatory schemes.

The distinction between the knowledge telling and knowledge transforming types of writing by Bereiter and Scardamalia (1987) is very important from the point of view of the idea of using writing as a tool for learning. Originally knowledge telling and knowledge transforming as different types of writing referred to cognitive processes *within* a person who is writing: A person tells or transforms his or her own ideas while writing. However, when the notions of knowledge telling and knowledge transforming are used in connection with learning they may also refer to processes in which a person tells or transforms knowledge borrowed from others or from textbooks, for example. Thus, knowledge telling and knowledge transforming may be inter-individual or social processes in learning situations. From this perspective, as forms of writing knowledge telling and knowledge transforming have an analogical conceptual pair in the field of learning. As I described at the beginning of this paper, some people consider learning a process of acquiring and increasing one's knowledge through acts of reproducing and memorising ready-made information (cf. knowledge telling), while others think that learning is a constructive and creative process where a learner constructs meanings and transforms ideas, and that this process will change her thinking (cf. knowledge transforming). The way in which teachers and students understand and conceptualise learning and in which they understand and conceptualise writing may affect the way in which they use writing for learning. If teachers think that teaching and learning is about transmitting and reproducing knowledge, it follows that they will design their students knowledge-telling type of writing tasks. In contrast, if teachers consider learning a constructive and transformative process they probably seek to promote this process by assigning students knowledge-transforming tasks, that is, tasks that do not allow them merely to reproduce knowledge from the textbooks but, instead, require them to make their own inferences and comparisons, find their own applications and examples and so on.

On the basis of his critical review, Klein (1999) concludes that the four hypotheses presented above address different operations and phases of composing and that accordingly the hypotheses are compatible with and complementary to one another. Thus, it is possible that all of them are sound. However, only the genre hypothesis has been systematically tested and verified from the viewpoint of learning. Klein suggests therefore that more empirical research is still needed to assess the validity of these hypotheses.

Although Klein's analysis of the hypotheses underlying writing-to-learn is penetrating and comprehensive, it lacks one significant viewpoint, an in-depth analysis of learning theories against the background of writing-to-learn research and of their relationship to the findings gained by it. Klein does mention that prevalent writing-to-learn education can be characterised as "constructivist", but the four hypotheses or research designs in general have not been discussed in terms of their underlying views of learning in his review. The hypotheses themselves represent the

cognitive position, which does not deal with the context of learning and writing or with the cultural practices in which learning and writing are embedded. Cognitive theories provide an important basis for understanding writing processes, but the picture of writing-to-learn changes considerably when writing and learning are considered not only as cognitive processes but also as social and cultural practices. Therefore theories of learning in understanding writing as a learning tool are essential.

Theories from cognitive research on learning

Cognitive psychology provides writing-to-learn studies theoretical understanding about the cognitive mechanisms that lead to learning in the sense of knowledge change or conceptual change. Schumacher and Nash (1991) have discussed four such mechanisms and the role they may play in writing-to-learn. The first mechanism thought to bring about learning is *perceived anomaly or inconsistency* that the individual cannot understand on the basis of her existing knowledge. The idea is rooted in Piaget's (1963) notion of cognitive conflict as a trigger of accommodation of an individual's knowledge structures and is further elaborated in recent theories on conceptual change (e.g. Posner et al 1982; Vosniadou 1994). It is assumed that when an individual realises that her thoughts or ideas are inconsistent with other people's views or new information this internal conflict leads the individual to reflect on her thinking and may serve to initiate conceptual change. However, the cognitive conflict does not automatically lead to knowledge changes but it requires conscious reflection. Therefore, the teacher's job is not only to arrange cognitive conflicts for students but also to organise tasks that involve discussion and in-depth thinking about these conflicts and their implications. The role of writing may be important here. Schumacher and Nash (1991) suggest that writing tasks that involve examining conflicting background material or interpreting information which conflicts with the writer's beliefs may be useful in investigating this hypothesis of knowledge change.

Another mechanism promoting conceptual change may be *using analogies, metaphors and models* as tools for coming to understand new information. Much research has been conducted in this area, providing convincing evidence that the use of analogies and metaphors may prevent the rise of misconceptions and promote understanding difficult and complex things (see, for example, Dagher, 1994; Guzzetti et al., 1993; Mason, 1994; Suzuki, 1994). Schumacher and Nash (1991) suggest that there may be at least three ways in which analogical mechanisms might play an important role in how writing affects learning. First, the writing task itself may bring about comparative processes in the similar way as in analogical thinking. This is the case in comparison/contrast essays, for example, which force the writer to consider similarities and differences between different domains. Second, the writers may use an analogical process in learning to write with new genres. For example, journalists may use their knowledge on writing with a familiar genre (e.g. a news story), for writing with an unfamiliar genre, (e.g. an editorial, to create "a news story with a tag opinion paragraph"; Schumacher et al. 1989). Third, writing tasks involving dealing directly with analogical or metaphorical content might bring about changes in the writer's conceptions of the topic domain.

The third mechanism that Schumacher and Nash present as a possible force behind knowledge change is construction of *multiple representations and active manipulation of ideas*. The importance of multiple representations of meaning is emphasised both by writing researchers and learning researchers. For example, according to Flower and Hayes (1984), the writers in the process of composing employ several modes of representation. As to learning researchers, the use of multiple representations of concepts and information during the study process is brought forward in several occasions (e.g. Ernest, 1995; Feltovich, Spiro & Coulson, 1993; Lehtinen & Repo, 1996; Lehtinen & Rui, 1995; Spiro et al, 1995). It is assumed that when new information is perceived

through more than one sense and processed in a variety of ways, cognitive structures become more complex and deep, involving rich associations between different elements.

The fourth mechanism of learning in Schumacher and Nash's analysis is *multiplicity of experiences* provided for learners. According to Spriro et al (1987; 1995) the creation of flexible knowledge structures (that is, knowledge that can be used in various situations) requires that knowledge is taught and studied in lots of different ways. Experiencing of and working with a variety of cases and examples is a means to gain multiple perspectives. Writing as a tool for expression provides an important channel for representations and dealing with experiences. Further, it has been suggested that writing serves learning the best when used in connection with other modes of expression and learning (Dysthe, 1996; Tierney et al.1989).

In addition to the four cognitive mechanisms conducive to conceptual learning presented by Schumacher and Nash (1991), there are at least three other mechanisms put forward by learning researchers: meta-cognitive awareness, critical reflection and collaborative learning.

The significance of *meta-conceptual awareness* for learning has been emphasised by researchers of conceptual change. For example, Vosniadou (1992) has pointed out that in order to promote knowledge restructuring instruction must be aimed towards increasing students' awareness of their existing beliefs about the phenomena to be studied. Becoming aware of one's implicit conceptions is a first step to changing these conceptions. The role of writing in making implicit beliefs explicit may be important and even crucial. For example, free writing exercises about the topic to be learnt before instruction help writers to externalise their thoughts and thus express their views. However, as Klein (1999) points out, simply articulating one's prior (mis)conceptions may not help one to challenge these ideas. Therefore active processing of new information and comparing it with prior knowledge is needed as well.

The notion of *critical reflection* in learning emerges from another school of thought, humanistic research on adult education. Reflective thinking has a central role in the experiential learning model presented by Kolb (1984), in Schön's (1983, 1987) accounts of reflection-in-action and reflection-on-action as a basis for a practitioner's learning as well as in Mezirow's (1991) notion of transformative learning, a learning process that makes the learner conscious of the presuppositions that underlie his or her conceptions and perceptions of the world. This process enables the learner to transform such underlying beliefs. Common to Kolb's, Schön's and Mezirow's theories is the strong emphasis given to reflective activities in learning. They all suggest that the key to adult learning and professional development is making explicit what has earlier been tacit and implicit, and thus opening it to critical reflection and transformation. Writing as a tool for critical reflection has been examined in several studies. For example, journal writing is proved a useful means to make thinking visible and tangible and, consequently, a focus of reflection (Ballantyne & Packer, 1995; Hoover, 1994; Lukinsky 1991, McCrindle & Christensen, 1995). Through journal writing the writer may engage in an internal dialogue. Although journals are personal and private texts, they can also be used as source material to promote dialogue with others in classroom discussions.

Collaborative learning is not a learning conducive mechanism itself but it is a pedagogical arrangement that may bring about cognitive and social mechanisms that promote learning (Dillenbourg, 1998). Using collaborative learning in education has been argued for on at least two different theoretical basis: on the basis of Neo-Piagetian research tradition on the one hand, and one the basis of Vygotskian view of learning as basically social activity. Neo-Piagetians' concept of socio-cognitive conflict (Doise & Mugny, 1984) refers to the anomaly situation that emerges when an individual recognises an inconsistency or conflict between her beliefs and others' views. Thus, social interaction between learners is supposed to lead to the learning mechanism mentioned at first in Schumacher & Nash (1991) analysis, an anomaly.

The Vygotskian argument for collaborative learning is based on Vygotsky's (1978; 1986) view of the social nature of learning. According to Vygotsky, learning takes place primarily on the social, interpsychological plane and only secondarily on the intrapsychological plane, that is, when a learner internalises what has first been experienced in social interaction. However, knowledge is not internalised directly but by means of mediating tools, especially language. Through this internalisation communicative language is transformed into an individual's 'inner speech' or verbal thinking. The ideal state for learning is what Vygotsky called the zone of proximal development. This concept refers to the distance between the learner's actual state of development determined by independent problem solving and the potential level of development that he or she can rearch through the guidance of adults or collaboration with peers. Thus, Vygotsky argued that through social interaction students may reach higher state of development than they would achieve by working and studying on their own.

When the social nature of learning is taken into account, the scope of writing-to-learn activities widens from individual composing operations to social and collaborative knowledge building. Seen from this perspective, writing-to-learn tasks should not be regarded as pure writing activities; instead they should be integrated with social interaction and classroom discussion and other school assignments. One possible way to do so would be small groups where students could discuss their individually performed writing tasks (e.g. Dysthe, 1996; Lonka & Ahola, 1995; Tynjälä, 1998) or collaborative writing activities requiring students to build shared understanding of a topic under scrutiny (e.g. Keys, 1994; 1995; Tynjälä & Laurinen, 2000). However, studies of the effects of collaborative writing on learning are still rare as most of the published research on collaborative writing is focussed on the improvement of the writing process and writing skills rather than on that of domain-content learning (e.g. Dale, 1994; Flower, Wallace, Norris, & Burnett, 1994).

Theories from socio-cultural approach

The third school of thought which may provide an important framework for research on learning and research on writing as well as for research on writing-to-learn is the socio-cultural theory. The basic tenet of socio-cultural approaches to language and learning is that all human activities, including learning, take place in cultural context and can be best understood against their socio-historical background. Human actions are not direct responses to environments' stimuli (as in behaviourism) but mediated by tools and symbol systems such as language. Vygotsky's (1978, 1986) ideas about the social nature of learning and the concept of the zone of proximal development have inspired much research on collaborative learning as well as on collaborative writing (e.g. Brown & Palincsar, 1987; Dale, 1994; Hoel, 1997; Mason, 1998). Similarly, Bakhtin's (1981; 1986) concepts of multivoicedness and dialogism have inspired studies relying on the interaction between students and emphasising the importance of integrating writing with other learning activities (e.g. Dysthe,1996; Nystrand, 1992, 2001). Bakhtinian dialogism supports learning situations where "various different points of view, conceptual horizons, systems for providing expressive accents, various social "languages" come to interact with one another" (Bakhtin, 1981). Not only oral communication but also texts may have dialogical functions (Lotman, 1990). It is assumed that an encounter between the conceptual systems of the participants of a dialog creates new understanding that is different from that the participants had before. These ideas about conceptual diversity or conflict as a source of developing thought have an interesting similarity with Piagetian ideas of the role of cognitive or socio-cognitive conflict in learning, although the theoretical foundations are different.

Altogether, the impact of socio-cultural theories to reseach on learning, writing and literacy can be seen in a growing amount of studies which emphasise the social context of learning and analyse interaction between and among students and teachers, negotiations of meanings and collaborative meaning making both in oral discussions and in composing texts.

EMPIRICAL STUDIES

In the preceding sections I presented different theoretical arguments put forward for using writing as a tool for domain content learning. What follows is a review of recent empirical studies which have drawn on these theories and in which practical applications have been devised and investigated. I begin with studies based on cognitive-constructivist theories on conceptual learning, continue with recent studies integrating learning theories, accounts of development of expertise and writing research. Finally, I shall review recent studies within the socio-cultural framework.

Writing as a means of enhancing knowledge transformation and conceptual change

Spivey (1997) has examined the constructivist metaphor as a means to describe the nature of reading, writing and learning and she has paid special attention to the integrative literary activity that she calls "discourse synthesis" (Spivey 1992, 1997), that is, writing texts on the basis of sources. She recommends using learning tasks that integrate reading and writing processes. When students write based on texts written by other people, reading and writing processes will blend. We cannot say where construction from reading stops and construction for writing starts. When using a text as a source of information a person is already mentally composing meaning for her own text when reading the source text, before putting pen to paper (or fingers on the keyboard!). Building of meaning is for the text being written as well as for the text being read and it involves making various kinds of transformations.

In her studies Spivey (1990, 1991, 1992, Spivey & King 1989; Nelson 2001) has analysed different forms of transformations taking place through the discourse synthesis. These transformations may be, for example, selective. When writers select content from reading multiple text to produce comprehensive reports, they tend to make their judgements on the basis of intertextual importance. The transformative process is also integrative. Writers have to build a coherent text of their own and therefore they often need to break down the structure of the source text and to organise their own production in a new way. This requires compressing the contents of the source text. Writers also have to make connections between their previous knowledge about the topic and the new information given by the source texts as well as across the multiple source texts. Connections may be made among ideas, among texts, among authors, and even among disciplines and domains.

The transformative cognitive processes of reading to write described above may produce rich inferences and elaborations of ideas. They may even lead to changes of the learners' prior conceptions of the topic under study. In recent years, one of the main fields of the research on learning has been studies concerning conceptual change. In these studies researchers have been interested in how students everyday conceptions of different phenomena - often described as 'misconceptions' in nature - may be developed towards scientific explanations. Among these studies there are several studies on writing-to-learn from elementary school to higher education. The following are some examples.

In a study by Mason (1998) talking-to-learn (collaboration) and writing-to-learn (individual work) activities were combined for fifth grade students for their studying ecological concepts. The

study indicated that these young students were able to produce both expository and reflective texts after group discussions about the topics under study. Almost all students showed the appropriation of new representations although at different levels. In several texts students' reflections on their conceptions indicated high level of metaconceptual awareness describing the changes from their initial conceptions towards their revised ones.

In another study Boscolo and Mason (2001) examined conceptual learning of fifth graders in history and science. In this study the students were divided into two groups: writing-to-learn group (experimental) and non-writing group (control). Both groups carried out usual writing tasks in history and science classes such as summaries and reports, but only the experimental group was assigned additional writing tasks aimed at promoting changes in students' conceptions (for example explicating students' beliefs and ideas about the topics, writing own comments on documents read, presenting hypotheses and own interpretations of the chapters read, expressing things that were puzzling). While the experimental group students carried out their writing tasks the control group students were engaged in drawing or in reproductive writing on the basis of teacher's dictation. The results of this study showed very clearly the positive impact on writing tasks to conceptual change. As measured with several measures of conceptual knowledge and metacognition, the students in writing group showed significantly better learning outcomes. The students in writing condition reached both a more advanced metaconceptual awareness of their learning and a deeper conceptual understanding in both disciplines.

Hand, Prain and Yore (2001) reported two studies about using writing for science learning in junior secondary school. In their first study two groups of students were assigned writing activities quite usually applied in science classes: note taking, review sheet and a unit test. In addition, the experimental group completed a letter-writing task in which they were required to explain what they understood about the topic, cloning, to a friend who was not familiar with the topic. In the other study with two similar groups science instruction covered usual writing tasks (note taking, concept maps, summaries, review sheet) for both classes except that the experimental class completed a series of additional writing tasks, the tasks named as Science Writing Heuristics (SWH) and a letter. The SWH is a framework aimed to facilitate students' scientific explanations in conjunction with the completion of laboratory work. The framework includes tasks of identifying students prior knowledge about the topic to be studied and tasks designed to facilitate students reasoning in constructing explanations form their laboratory work.

In the first study there were no significant differences in the learning outcomes between the experimental and the control group. Instead, in the second study the students who completed the SWH tasks and the letter writing task answered higher-lever test questions significantly better than the students who did not experience these writing tasks. However, the difference between the groups on the lower-level items was not significant. The authors conclude that the use of sequential writing-to-learn tasks facilitates students' learning of higher level concepts without enhancing lower-level learning. In addition, the findings of this study afforded further evidence in support of the findings by Boscolo and Mason reviewed above that writing tasks are useful to develop students' metaconceptual understanding. The findings of the study suggest that sequential tasks can promote new links between concepts to be constructed thus promoting knowledge transformation. The study also raises the issue concerning effective task design. The authors suggest that a promising sequence of tasks involves students in writing for different purposes, for different audiences and in diverse range of genres.

In one of my own studies of writing for conceptual change (Tynjälä 1997, 1998) the focus was on how education students' conceptions of learning develop during a writing-to-learn course. The study was carried out in a course which dealt with theories of learning and development. At the beginning of the course all students wrote a short essay, "My conception of learning" after which the participants were divided into two groups. The traditional learning group studied the course material individually, listened to the lectures and took and exam while the writing-to-learn group

worked with different writing assignments requiring knowledge transformation, discussed their assignments in groups and wrote an essay. The tasks required the students, for example, to activate their previous knowledge, to compare it with the knowledge presented in the textbooks, to compare different theories or approaches, to examine the theories in the light of their own experiences, to criticize the theories, to apply theoretical concepts to real-life situations, to prepare summaries and to write a fictional or true story using theoretical concepts. The essays on students' learning conceptions written before and after the course were analyzed and as a result of the study it was found that the students' conceptions appeared to change quite similarly in both groups with the exception that at the end of the course the students in the writing group emphasized more often the role of critical thinking and other student activity in learning. This way their conceptions changed more towards constructivist views of learning than those of the traditional group. Further, an interview study among the same groups indicated that the writing group students described their learning in a greater variety of ways than did the students in the control group. They emphasized the development of their thinking, changes in their conceptions of the topics studied and their acquisition of communication and study skills significantly more than the traditional group students. These findings suggest that activating textbook reading by means of writing tasks combined with group discussions may enhance learning of the kind that higher education is aiming at: understanding, conceptional change and the development of critical thinking.

Writing and the development of professional expertise

Recent research on the acquisition of expertise has suggested that the integration of theory and practice is a key to the development of professional expertise (Boshuizen et al, 1995; Bromme & Tillema, 1995; Leinhardt et al., 1995). The pivotal question which follows is how this integration may take place. Leinhardt et al. (1995) have suggested that true integration of theoretical and practical knowledge is best fostered when students transform abstract theories and formal knowledge for use in practical situations and, correspondingly, when they employ their practical knowledge to construct principles and conceptual models. Thus, theorizing practice and particularizing theory are important. Experiential learning theorists refer to this same process in terms of reflection: learning takes place through a cycle of experiences, reflection, conceptualization and experimenting (Kolb, 1984). Finally, Bereiter and Scardamalia (1993) suggest that formal knowledge is converted to an experts' informal knowledge through problem solving.

I suggest that writing can serve as a mediating tool for these purposes of integrating theoretical and practical knowledge. Many studies have shown that writing can successfully be used as a tool for reflection and analytic thought, making implicit presuppositions and beliefs explicit and thus objects of transformation (see, for example, Ballantyne & Packer, 1995; Brown, 1998; Harrison, 1996; Lyons, 1999). Writing tasks can also be used to examine theoretical knowledge from the viewpoint of practice, to analyze practical experiences in terms of theory, to solve problems of understanding and to devise strategies for solving practical problems with the help of theoretical knowledge (Tynjälä, 1998). Furthermore, Scardamalia and Bereiter (1991) have argued that literate expertise involves a dialectical process that serves to advance domain knowledge. They hypothesise that the knowledge transforming type of writing enhances simultaneously both writing expertise and subject-matter understanding. I have suggested (Tynjälä, 2001a,b) that the use of writing as a learning tool can also provide an important basis for fostering general skills that future experts need in the symbolic-analytic or knowledge-intensive jobs of the information society such as abstraction, communication and collaboration skills, systemic thinking, critical thinking skills, analyzing and synthetisizing skills as well as metacognitive and reflective skills. This requires that we take into account what is known about the development of expert knowledge and the nature of

learning and that we use writing as a tool for transforming and creating knowledge as an authentic activity.

The hypothesis by Scardamalia and Bereiter about writing as a tool for promoting domain-specific expertise as well as my idea about the potential of writing for developing general expert skills are very difficult to test directly and experimentally because professional expertise or domain expertise in general is a complicated phenomenon, and it is no sense to try to reduce it into manageable and controllable pieces to measure. However, the study on education students' writing-to-learn course that I described in the previous section represents a case study in which theories of acquisition of expertise and research on writing-to-learn were integrated to form a conceptual framework for developing instructional practices aimed at facilitation of professional expertise needed in today's working life (Tynjälä 1998, 1999). In addition, a further study on combining individual and collaborative writing tasks to enhance learning from textbook was conducted (Tynjälä & Laurinen 2000). In these studies the writing tasks included reflecting students own experiences on the basis of theoretical knowledge, examining, comparing and analyzing theories presented in the textbooks, criticizing theories, applying theoretical concepts into real life situations and so on. The idea was to integrate theoretical knowledge and students practical experiences through writing tasks. In both studies students carried out both individual writing assignments that served as a material for group discussions in one study and for collaborative writing tasks in another study. When students' subjective experiences of their learning was examined in both of these studies the participating students described their learning outcomes in a way that is much similar to the statements presented about the requirements of professional expertise in today's society. Students depicted their learning not only in terms of improved domain content knowledge but also in terms of general and transferable skills such as critical thinking skills, analyzing skills, and collaboration and communication skills. Among the control group students (the control group was used only in the former study) the descriptions of this kind were almost missing.

Another example of studies inspired by theories of expertise development is a study about working life oriented project-based course in information technology (Tynjälä & Tourunen, 2000). This study is not exactly a specific study on writing-to-learn but rather a study on project learning. However, writing played an important role in the work and learning processes which makes the study interesting from the perspective of writing to learn. The aims of the project course were to integrate theory and practice in the domain of information systems design, to provide students with personal experiences in project work and to develop personal transferable skills, such as cooperation and oral and written communication skills. At the beginning of the course the students were divided into project groups of 4 to 5 members. During the course the groups produced a developmental plan or designed some other product for an authentic client company. At the same time they took parallel courses on teamwork and oral and written communication. (Eteläpelto & Tourunen, 1994; Tourunen, 1996; Tynjälä & Tourunen, 2000). Writing was used as an authentic activity and as a tool for reflection and self-assessment during the course. It was put to the following uses: 1) for documenting and reporting different phases of project work (process writing; "records"), 2) for reflecting on the learning processes, and 3) for self-assessment and group-level assessment of learning. At the beginning of the course all students wrote a short essay on their conceptions of project work, their expectations and personal learning goals. Using collaborative writing, each group also produced an essay on the starting situation and shared aims of the group. During the course and at the end of the course the students assessed their progress and reflected on their work both on the personal and the group level. Students, tutors and representatives of the client company were asked to write assessment documents twice during the project process, halfway through and at the end of the project. Each project group had a journal or diary in which the head of the project wrote personal comments and notes on the most significant and important events during the process. (Each member of the group served as a head of the project on their turn). Thus, during the project the students produced a diverse collection of written materials: project plans, co-

operation messages, minutes of meetings, reports on client interviews, plans for and reports of content for the client, computer software designed by the group, self-reflective essays and narratives, journal entries, and so on.

The assessment of the student projects was conducted as three-way partnership assessment in collaboration with the students, the teachers and the client enterprises. (The assessment procedures are described in more detail in Tynjälä & Tourunen, 2000). On the basis of the analysis of the students self-assessment reports five different types of experienced learning outcomes were found: 1) Domain specific skills, including programming skills, use of specific methods and tools, professional attitude and applications skills, 2) Overall view of the project work, including different roles and phases of the project and planning procedures, 3) Cooperation and communication skills, such as negotiating skills, group work skills and writing skills, 4) Resources management skills, such as time management, and 5) Social skills, including getting along with different people, self-expression and skills to teach and guide others. (Tynjälä & Tourunen, 2000). These descriptions of students own learning suggest that the aims of the course were well achieved. In addition to the analysis of students self-assessment reports, the assessment documents by teachers and the enterprises are being analysed. The analysis is still going on but our preliminary findings suggest that the students' positive assessments are confirmed by the teachers and the client enterprises. A content analysis of expressions of the assessment documents suggests that all the three partners of the projects share the experience of success of the project course. Both the teachers' and the client enterprises' assessments were very positive and all the project groups got a good or excellent grade of the course. Altogether, the three partners agreed that the project course had developed the skills needed in IT-professionals work and that the products student groups produced were of high quality (Tynjälä & Tourunen, 2000). It is not possible to analyse in detail to what extent these outcomes are due to writing and to what extend to other components of project work, but it is clear that writing played an important role in the students' activities during the course. Furthermore, writing proved to be an excellent tool for students to use for reflecting on and self-assessing their learning.

Writing as a part of school learning culture

Many distinguished scholars on the field of educational research have pointed out that the cultures of schooling much differ from the cultures of "real life" and that this state of affairs has been detrimental to student learning and the development of expertise (Bereiter & Scardamalia, 1993; Mandl et al., 1996; Resnick, 1987). For example, Bereiter and Scardamalia (1993) have stated that the educational system looks like being designed as if its purpose were to produce non-experts instead of experts. As Resnick (1987) has pointed out school activities are characterized with pure mentation while outside school most mental activities are engaged intimately with tools; school learning is generalized whereas situation-specific competencies are needed in "real life"; school work is based mostly on individual cognition and students are assessed on the basis of individual performances while shared cognition and shared expertise are necessary in working life. In short, in schools students are required to behave in a way that is not the way how people in working life behave. Writing as a part of general school culture is not an exception. Geisler (1994) has shown in her study that reading and writing practices in school are quite different from those of experts: students write for reproducing and displaying knowledge while experts write for analyzing, transforming and creating knowledge. School seems to be a "reproducing community of practice" as Lave and Wenger (1999) have put it, whereas modern work organizations can be characterized as knowledge transforming innovation centers.

Recent sociocultural studies on learning have produced rich empirical descriptions on how school cultures and practices work and how they influence student learning. In their large-scale study of classroom instruction in high school English and social studies Nystrand, Gamoran and

Carbonaro (2001) showed that classroom discourse and writing typically proceeded independently of each other in most school instruction. That is, writing tasks and classroom discussions were not integrated. Although writing and discourse usually proceeded independently it was found that classroom discourse influenced students' writing performance. Writing performance was higher in classes in which more time was spent in oral activities. Also coherence, that is, the extend to which writing related to reading, reading to talk, and talk to writing, significantly affected writing performance in both social studies and English. A surprising result from the study was that although students wrote as often in English as in social studies, frequency of writing enhanced writing in English but had an opposite effect in social studies. This finding lead the researchers to take a closer look on the qualitative features of writing in these two subjects. Their finding was that there were fundamental differences in purposes and emphasis on writing between English and social studies. In its emphasis on rhetoric and form, English classes displayed more attention to writing as writing, whereas in social studies writing was used for reproduction and recall of information. The writing tasks most teachers used in social studies typically required no critical thinking or transformation of knowledge but emphasized recall. Further, in English editing and revising were more than twice as common than in social studies. Therefore it was no wonder that writing performance improved in English.

In the study by Nystrand and his colleagues the writing performance was measured but no analyses of learning in terms of knowledge restructuring or conceptual change were conducted. Thus, it is not possible to make any direct conclusions about students' domain content learning in the classes studied (except that in English writing is part of domain content). However, the findings concerning the ways how writing was used in social studies suggest that the view of learning underlying the instruction represented the traditional transmission and reproduction paradigm. Writing was used to reproduce knowledge, not as a tool for developing thinking, argumentative skills or knowledge transformation and conceptual change.

The findings of the study about the importance of coherence among different forms of classroom activities - reading, writing and talking – are supported by case studies of Dysthe (1996; see also Hoel, 1997). In three case studies of classroom interaction the teachers aimed at changing their teaching through bringing writing in subjects where writing traditionally had been used only for testing. In one case the teacher encouraged students to write and talk but kept writing and talk separate. Instead, the other two teachers created interactional patterns where various forms of writing and talk interpenetrated one another. In other words, these two teachers combined writing and classroom discussions. Common to both these classes was that writing assignments and oral questions were very often authentic (that is, questions without no prespecified "right" answer) requiring students to actually think, not only repeat what the textbooks say. Furthermore, the assignments encouraged students to tie the concept under study to their personal experiences. By presenting detailed examples of integrating writing and discussion Dysthe illustrates how this integrative approach pushed students to think critically, how meanings were negotiated through collaborative writing and talking, and how knowledge was consolidated through this process. Qualitative analysis of the classes showed that this way the texts were used to generate thoughts and opinions among students. The findings suggest that the interaction of oral and written discourse increased dialogiality and multivoicedness in the classrooms and thus provided more changes for students to learn than did talking or writing alone. Dysthe concludes that by separating writing and talk the third class teacher lost many opportunities for student learning.

CONCLUSIONS

The studies reviewed in this paper illustrate the wide range of the ways how writing is used for learning in schools and colleges. In some studies writing was used for reproduction of knowledge as

was the case in social studies classes in the study by Nystrand et al. (2001). In some other studies students were assigned writing tasks in order to bring about critical thinking, knowledge transformation or conceptual change (Boscolo & Mason, 2001; Dysthe, 1996; Hand et al, 2001; Tynjälä, 1998; Spivey, 1990, 1997) or to develop the kind of expertise needed in working life such as collaboration and team work skills, communication skills and analytic thinking skills as integrated with the development of domain specific understanding (Tynjälä & Laurinen, 2001; Tynjälä & Tourunen, 2000). It is questionable whether reproductive ways of using writing have any benefits for learning, and the findings by Nystrand and his colleagues indicate that they may even deteriorate students' writing performances. Instead, the studies in which writing was used for transforming knowledge, developing thinking and promoting metacognitive and reflective skills produced encouraging results.

There were also differences in the ways how writing was related to other school activities such as textbook reading or classroom discourse. In some classes writing and discussions were separated (in classes studied by Nystrand et al. 2001, and in one case of Dysthe's 1996 study), whereas in other classes writing tasks were integrated with group discussion, whole class discussion, textbook reading or project work (two cases in Dysthe's 1996 study, Mason 1998; Tynjälä, 1998; Tynjälä & Tourunen, 2000). The findings of these studies suggest that probably the most beneficial use of writing is to combine it with other forms of discourse and studying. When writing is integrated with textbook reading, group discussions and different project-work activities, for example, students are simultaneously exposed to a broad range of cognitive processes, which may make the effect of each component method stronger than when used separately. Furthermore, this way the benefits of both collaborative learning and individual writing processes can be achieved at one and the same time. A study by Lonka & Ahola (1995) indicates that this kind of activating instruction has long-term effects on student learning, leading to better academic success than traditional instruction.

Different ways of using writing as a learning tool reflect different conceptions of learning. I have argued elsewhere (Tynjälä, 1999; 2001) that the most important element in the pedagogical reform should be the change in the conception of learning. The traditional view of learning and instruction as processes of transmitting, accumulating and reproduction of knowledge has lead to school practices in which the student is left as a passive recipient of information. When this view of learning dominates, also the activities that could be used in a constructive way, such as writing, tend to be used for reproductive purposes. In contrast, current constructivist and social constructivist epistemologies and theories of learning imply an active role of the student: learning is not about receiving of information but about constructing knowledge in social interaction. Further, new conceptions of learning do not confine themselves to a metaphor of knowledge acquisition but they also describe learning as participation in practices of social communities. (see, Sfard, 1998). Thus, learning is seen as a process of becoming a member of a certain community, becoming able to communicate in this community and act according to its norms. Like learning, writing is an activity that can be described both as a constructive and a participatory process. Through writing an individual may construct meanings (see, Spivey, 1997) and participate in discussions with other people. Through writing an individual may transform knowledge (Nelson, 2001; Spivey, 1990, 1997) and create knowledge (Galbraith, 1999). New conceptualizations of learning clearly imply the use of writing for learning in this way.

Recent research on learning and instruction has indicated that promising learning environments encourage active learning and support students' learning process, support communication among students and between students and teachers, use both individual and collaborative working methods, integrate theory and practice, deal with real life problems, promote metacognitive and reflective skills, and apply and integrate diverse forms of studying (e.g. Duffy, Lowyck & Jonassen, 1993; Lonka & Ahola, 1995; Tynjälä, 1999; Vermunt, 1995). I suggest that by integrating these principles of good learning with theoretical constructions provided by research on

learning and research on writing we may develop a convincing basis for studies of writing to learn. The notions of spontaneous idea generation, forward and backward search, genre, and knowledge transformation in combination with the concepts of anomaly, analogy, multiple representations, metaconceptual awareness, reflection and collaborative learning provide rich foundations for devising pedagogical applications for future studies. Moreover, further studies on school learning cultures are needed. Especially studies comparing innovative learning cultures and traditional learning environments would be important because through such studies we could identify the most critical contextual factors determining student learning.

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